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Human cloning and the potential effects on evolution

Summary

Sometime in the distant future, human cloning might become a practically feasible. It is no longer a thrilling wisdom of science fiction. The technique is available. The question is whether it would be ethically and socially acceptable including the potential concerns that might be associated with cloning humans. Compared to a natural embryo, which has a genome resulting from the mixture of six sources, a cloned genome would essentially have a single source. This would certainly rob off the unique characteristics a natural child possesses. Its short- and long-term effects, however, are unknown. Cloning research on human cells has the potential to revolutionize the treatment of several medical problems in the future. There are, however, some concerns about cloning a human.

Even if it became feasible and safe (in relation to the health of the individual produced) in the future, the long-term effects of bypassing fertilization, on evolution in particular, would be interesting.

N.B. The idea was originally conceived by the author and the article written in December 1998. The core contents have been left as these were in 1998.

Keywords: human cloning, evolution, crossing over

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Introduction

Sometime in the distant future, human cloning might become a practically feasible. It is no longer a thrilling wisdom of science fiction. The technique is available. The question is whether it would be ethically and socially acceptable including the potential concerns that might be associated with cloning humans. Dolly, The sheep, was the first mammal to be cloned from a single adult cell, accomplished by Ian Wilmut, Keith H. S. Campbell and colleagues at the Roslin Institute and PPL Therapeutics, near Edinburgh, Scotland.[1] The researchers of the infertility clinic of Kyunghu University Hospital in Seoul, South Korea have already claimed that they had fused an adult human nucleus with an enucleated egg (the "Honolulu technique") creating the first human clone that had reached the four-cell stage. The experiment was halted at that stage to avoid contravening local ethical guidelines. Concern has been expressed in the editorial of The Lancet that in future some research group will succeed in cloning human.[2]

The Worldwide responses to human cloning have been mixed. It has been banned by several countries and declared unacceptable by the Christian, Jewish, Muslim and Buddhist faiths.[2] The scientific community has expressed concern that a broadly worded ban would block basic and applied research using cloning techniques on human cells-research, which has the potential to answer important questions in cell regulation and to make therapeutic advances.[1] Cloning research on human cells has been made legal in the UK. As all other advances in human reproduction, human cloning has raised ethical and moral issues, which possibly would subside with the passage of time as has happened before.

Methods of cloning

There are essentially two techniques. First, cells taken from an adult or an embryo are grown in a flask under conditions that encourage them to divide and increase their numbers, and to trick them into reverting to a non-specialized state with the potential to form an entirely new individual. Second, the nucleus of a donor cell is transferred to an egg from which the nucleus had been removed (nuclear transfer).[3] The result is an animal that is essentially an identical twin of the donor animal, although the cloned offspring has a small genetic contribution – the mitochondrial genome – from the animal providing the enucleated egg cell.[1]

Possible roles of cloning

Besides providing selective infertile couples with an identical copy of one of them, human cloning has widespread potentials. It could help in generating completely compatible bone marrow, skin cells, organs etc for transplant. It may be useful in treating genetic disorders (e.g. mitochondrial diseases), diabetes etc or generating nerve cells in patients with degenerative neurological disorders. It may give insight into the function of mitochondrial genes in development, the phenomenon of genetic imprinting and the consequences of ageing on genome.[1,4]

Concerns about cloning

Some concerns have been expressed that if a cell used for cloning contains accumulated mutations acquired during years of cell division in the individual donating the nucleus, the resulting clone may begin life with a predisposition to ageing and age-linked diseases (e.g. cancer).[1] Dolly, the sheep, has already shown signs of premature ageing. During the life-time several mutations in the DNA sequence occur along with epigenetic changes. They could be adaptive, triggered by environmental changes. This could then be passed on to the offspring. Concerns have been expressed about the transmission of the impact of manipulations associated with cloning to future generations as well.[5]

Human reproduction and unique individual

The fundamental event creating a new life in humans is fertilization of an ovum by the sperm. Both the cells contain haploid (23) chromosomes, which fuse at fertilization forming the diploid zygote

containing 46 chromosomes. This maintains the normal diploid chromosome status of the human somatic cells. Both sperm and ovum are the end result of meiosis whereby haploid gametes are formed from diploid primitive gamete cells.[6] The important event of crossing over occurs during the four-strand stage of meiosis I (pachytene), when exchange of homologous segments takes place between non-sister chromatids of a pair of homologous chromosomes. However, each crossing over event involves only two of the four chromatids. Thus for each recombination event there are four products, two of which are recombinant and two non-recombinant. One genetic crossover is equivalent to 50 percent recombination between loci on opposite sides of the cross over. This fact emphasizes that a chromosome inherited by a child from for example, the father is essentially never exactly the same as either of the two copies of that chromosome in the father's genome. Rather the child's chromosome consists of alternating portions of the paternal grandfather's chromosome and the paternal grandmother's chromosome. If this concept is extended over the entire karyotype, the human genetic individuality would be self-explanatory.[6,7] During his or her lifetime the child would acquire several genetic mutations and epigenetic changes, which would be propagated to the offspring through the gamete.[5] At fertilization two gametes with different chromosomal characteristics would fuse to form another unique individual.

Cloning and unique individual

Crossing over and fertilization are two important events, which lead to unique characteristics of the individual with the possibility of acquiring characteristics from six sources, the maternal and paternal grandmothers and grandfathers, and the parents. In cloned individual, the genetic contribution would essentially be confined to the donor. If an adult-cell is cloned, the result would be an identical twin of the donor without any crossing over and mixing of genetic characteristics of the parents of the donor. If nuclear transfer is used, there would be some genetic contribution from the mitochondria of the recipient cell besides the contribution from the donor nucleus. But the effect of this is yet unknown. However, in both circumstances the nuclear genetic contribution would essentially be confined to the donor genome. Compared to a natural embryo, which has a genome resulting from the mixture of six sources, a cloned genome would essentially have a single source. This would certainly rob off the child of the unique characteristics, a natural child possesses. Its short- and long-term effects, however, are unknown.

Conclusion

Cloning research on human cells has the potential to revolutionize the treatment of several medical problems in the future. There are, however, some concerns about cloning a human. Even if it became feasible and safe (in relation to the health of the individual produced) in the future, the long-term effects of bypassing fertilization, on evolution in particular, would be interesting. While it might not be apparent with cloning a handful of individuals, the question is what would happen in case of mass production?

Author's role

Sudipta Paul is the sole Author who contributed to the study including participation in study design, execution, analysis, manuscript drafting and critical discussion.

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Conflicts of interest

The authors declare there is no conflict of interests.

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